DEPARTMENTAL SEMINAR

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TOPIC	**Catalytic Membrane Reactors and Novel Trends in Catalysis**
SPEAKER	**Prof J. Caro**
HOST	**Prof Hong Liang**
DATE	**27th February 2009 (Friday)**
TIME	**10am**
VENUE	**E5-02-32 , Faculty of Engineering, National University of Singapore** **NUS Campus Map & NUS: Faculty of Engineering**

SYNOPSIS

Catalytic Membrane Reactors

Conversion enhancement in extractor type membrane reactors

To overcome the equilibrium restriction for the thermodynamically controlled reactions, the reaction must be sufficient fast compared to the mass transport through the membrane (kinetic compatibility). The reactions in this category include dehydrogenations of alkans to the corresponding olefins, esterification, steam reforming of methane to synthesis gas (CO, H_2), Knoevenagel condensation, thermal water dissociation into H_2 and O_2, and nitrous oxide (N_2O) decomposition to N_2 and O_2.

Selectivity enhancement in distributor/contactor type membrane reactors

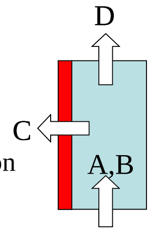
In this case, the desired product is either an intermediate in a consecutive reaction or is one of the products in a system of parallel reactions. Reactions such as oxidation of hydrocarbons (including partial oxidations such as the oxidative dehydrogenation of alkanes to olefins and the oxidative coupling of methane to C_{2+} hydrocarbons), the partial oxidation of methane to synthesis gas and partial hydrogenations of di- or multi-unsaturated hydrocarbons to less saturated ones belong to this category.

Thermodynamically controlled reactions	Kinetically controlled reactions
$\Delta_R G^0$ near zero	$\Delta_R G^0$ very negative
$\Delta_R G^0 = -RT \ln K \rightarrow K \approx 1$	$\Delta_R G^0 = -RT \ln K \rightarrow K >> 1$
$A + B \leftrightarrows C + D$	$A + B \rightarrow C + D$

Extractor type membrane reactor

Conversion enhancement:

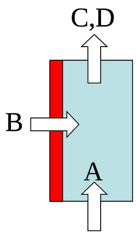
- Dehydrogenation
- Esterification
- Steam reforming
- Knoevenagel condensation
- Water splitting



Distributor type membrane reactor

Selectivity enhancement:

- Hydrocarbon oxidation
- p-Xylene oxidation
- Methane to synthesis gas
- Partial hydrogenation
- Methane oxi-coupling

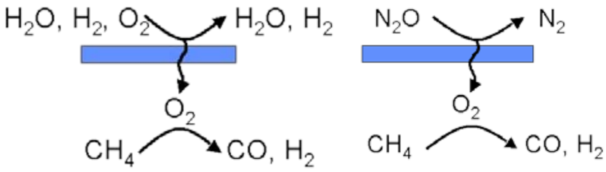


Novel Trend in Catalysis

In this section, high throughput catalyst development by robots, parallel automatic testing of catalysts and catalysis in micro reactors will be presented.

Membrane supported reactions

- Water splitting
  $H_2O \leftrightarrows H_2 + ½ O_2$ (left)
- Nitrous oxide abatement
  $N_2O \rightarrow N_2 + ½ O_2$ (right)



BIOGRAPHY

J. Caro is a full professor and the director of the Institute of Physical Chemistry and Electrochemistry at the University of Hannover since 2001. He served as the President of the German Catalysis Society in 2005 and 2006. He is also a member of the Board of Directors of the German Membrane Society and a speaker of the Lighthouse Project for the German Research Ministry (with 12 partners from industry and academic community). Prof Caro has published over 190 papers and is currently having 38 patents under his name. He is also a member of the Editorial Boards of 5 established journals, including Advanced Materials, Micropor. Mesopor. Materials and Catalysis Communications.

A L L A R E W E L C O M E

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